THE YARYAN PROCESS AND APPARATUS FOR EVAPORATION OF LIQUIDS.

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We present to our readers the following description of the Yaryan process and apparatus for evaporation of liquids, not only as of interest from a scientific point of view, but because the "Yaryan" has become so essential a part of many manufactories that a thorough knowledge of its construction and working is necessary to every engineer. We give illustrations showing a quadruple effect in plan elevation and section and a perspective view of a vertical triple effect.

The process of M. Rillieux, invented in 1830 for evaporation by triple effect, had, up to the time that Mr. Yaryan gave his attention to it in 1885, never been improved upon. This device, though defective in many ways, was still so great an advance that for more than fifty years no further steps were taken. As recently as 1882 M. Paul Horsin Deon, in his treatise on sugar making and evaporation, remarks that "the working principle of Rillieux apparatus must never be changed, as it has never been improved upon."

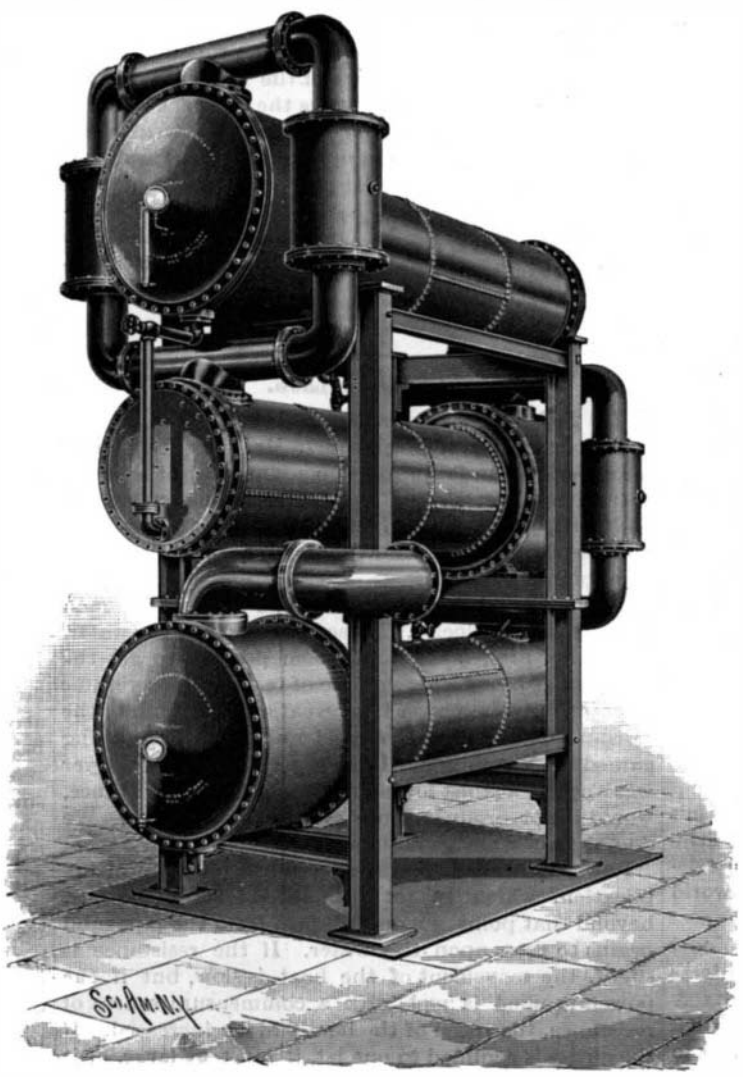
The distinguishing features of the Yaryan system are film evaporation and the rapid motion of the liquid through the tubes during the process. With regard to the latter point, the experiments of Herr Hugo Jelinek, of Prague, show the following results:

Velocity of the liquid per second in meters.	Calories absorbed per square meter.
0·312	22·7
0·640	33·6
1·020	46·9
1·640	69·9

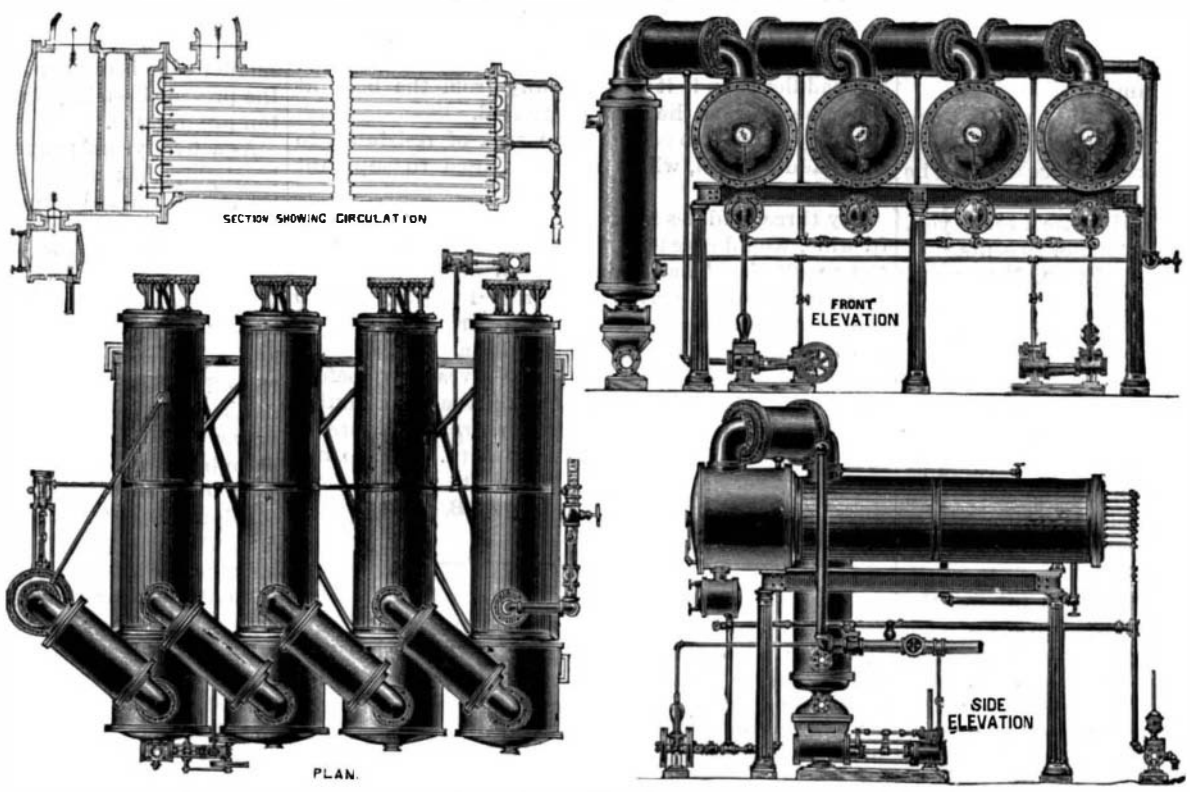
It is claimed that in practice the Yaryan apparatus shows an efficiency per square foot of heating surface of more than double that of any previously known. At the exhibition of novelties at the Franklin Institute in Philadelphia in 1885, two successive tests before the judges showed an evaporation of 31·5 pounds of water per square foot of heating surface; the temperature of feed water being 125° Fah. A second test was demanded by the judges, such efficiency seeming impossible. A medal was finally awarded the Yaryan Company upon these tests. This high efficiency is gained partly by film evaporation and partly by the rapid motion of the liquid. Other advantages of the rapid motion are that no particle of the liquid to be evaporated remains long in contact with the heating surface and that scale forms with less rapidity. In the treatment of many solutions this is of the greatest value, as continued subjection to high temperature would injure the product. For example, in the boiling of sugar great care has to be taken not to produce caramel, thus injuring the color by overheating.

The operation of the Yaryan apparatus is as follows:

The steam, which may either be exhaust from the engine or live steam direct from the boiler, is led into the cylindrical chamber surrounding the coils in the first effect. The liquid to be concentrated is fed into the first tube of the return bend coils of the first effect in a small but continuous stream and immediately begins to boil violently, becoming a mass of spray, containing as it rushes along the heated tube a constantly increasing proportion of steam. The inlet end of the coil being closed to the atmosphere, and steam being continually formed, the contents are propelled through the tubes at a high velocity, finally escaping from the last tube of the coil into the separator. Here the now reduced volume of liquid falls to the bottom, while the vapor passes away at the top, coming in contact in its passage with a series of baffle plates in the separator which remove any entrained liquid. From the separator the steam passes through an ingeniously constructed catch-all which effectually removes any liquid which may still remain to the chamber surrounding the coils of the second effect, where its heat produces the further evaporation of the reduced liquid. In the second effect, the liquid is led from the bottom of the separator of the first effect into the coils, and the same operation takes place as in the first effect, and so on through the entire system, whether triple, quadruple or more effects are used. The steam from the final effect goes to the condenser and vacuum pump, a vacuum of twenty-eight inches being thereby maintained in the separating chamber and consequently in the coils. Hence, the boiling point of the liquid is at a lower temperature than that of the surrounding steam, and by the condensation of the steam from the previous effect upon the cooler pipes in this effect, a vacuum of a less degree is maintained in the next preceding effect. This relative reduction in pressure, and consequently boiling temperature, automatically adjusts itself, however many effects are used, thus effecting the boiling of the liquid by the steam produced by its own evaporation in the previous effect.



YARYAN'S TRIPLE EFFECT APPARATUS.



YARYAN'S EVAPORATING APPARATUS—QUADRUPLE EFFECT.

The advantages claimed by the Yaryan system over other systems of evaporation, whether in vacuo or open air, are as follows: 1. It is more economical in steam, using the latent heat at different temperatures with a greater number of effects than any other system. Many are in operation having four effects, and the system may be carried to six effects without difficulty. 2. It is automatic in its action, taking its own supplies required and delivering the product concentrated to the exact density desired continuously. 3. The liquor is not subjected to high and injurious temperatures for more than two minutes, while in all other systems large quantities are retained for a long time under those conditions. 4. The pumping and mechanical arrangement is much simpler and less liable to get out of order. 5. The priming and consequent boiling over of frothy liquids is absolutely prevented. 6. The entire apparatus is easily cleaned. 7. The apparatus is lighter in itself, and inasmuch as but a small quantity of liquid is contained in it for a given time, it requires a less expensive foundation. It also occupies less space than any other machine for the purpose. 8. There is absolutely no coloring of the liquid during the process of concentration. 9. An evaporative efficiency more than double per square foot of heating surface over any known system of evaporation.

To the manufacturer of sugar, whether from cane or beet juice, or in the refinery to reduce sweet water, the Yaryan evaporator is of especial interest, owing to the large quantities of liquor which must be handled daily and the liability to inversion which all sugar solutions possess. With the ordinary triple effect, the heat of the first effect—which reaches nearly 200° F.—and the length of time it is subjected to this heat are fruitful sources of inversion. With the Yaryan system frequent tests with the polariscope demonstrate that there is no inversion whatever, and consequently no loss of sugar. As previously explained, this is one of the advantages of the rapid motion of the liquid through the machine.

The "Yaryan" has been adopted by over 100 of the leading sugar refineries throughout the world, including La Refinerie C. Say, of Paris; Messrs. Henry Tate & Sons, of London; Messrs. Hogg, Curtis & Campbell, of London and Demerara; Stewart Gardner, Esq., of London and Demerara; Messrs. Gardenin Brothers, of Lipetsk, Russia; The Havemeyer Refining Company, of New York; Messrs. Harrison, Fraser & Co., of Philadelphia.

Previously to the introduction of the Yaryan system, every attempt to evaporate the spent alkali liquor of soda pulp mills had proved a total failure. This liquor, which is the waste product resulting from boiling the wood in a solution of caustic soda, is a liquid resin soap and quickly becomes a mass of froth under the action of heat. In the Yaryan apparatus this froth, which formerly baffled all efforts looking to the recovery of the soda, is beaten down by the rapid motion of the liquid and more rapid motion of its vapor over it, with the result that no priming over of the liquid takes place. To-day the "Yaryan" is an indispensable adjunct in every soda pulp mill of any consequence in the United States. No soda pulp mill could to-day compete with its rivals without it.

While in the manufacture of fish glue the Yaryan is a recognized necessity, in the manufacture of hide glue the manufacturers are only beginning to wake up to its advantages, and to such we would suggest a careful investigation. In the manufacture of hide glue it is generally supposed that the liquors do not require evaporation, as they will set firmly enough as run from the digestors.

Although this is true with the firsts and seconds, the practice of using thirds to boil fresh stocks with is objectionable. Certain enterprising manufacturers, recognizing this point, and the adaptability of the Yaryan to their needs, have adopted the practice of evaporating their thirds by means of this apparatus and making it into a grade of glue by itself. Experimenting further, they have found great advantage in evaporating the first and second liquors in the Yaryan, with great gain in economy of time, in drying, and of space.

For bone and pigs' feet glues, which must be reduced to at least 18° Baume in warm weather, the Yaryan ap-

paratus is especially adapted. The difference in product obtained by firms using it, as compared with that made by the crude and barbarous methods of open evaporation, is most marked, to say nothing of the economy of production.

In the production of glycerine, the leading manufacturers thoughout the world have adopted the Yaryan system. By its use, an article much nearer anhydrous, viz., 1,264 specific gravity, is produced without loss, than can be obtained by use of the vacuum pan, and at one-half the cost of evaporation.

Among the manufacturers of glycerine using the Yaryan apparatus are Price's Patent Candle Company, of Birkenhead, England; Messrs. Proctor & Gamble, M. Werk & Co., and the American Glycerine Co., of Cincinnati, Ohio.

Other users of the Yaryan evaporator are: Manufacturers of glucose, gelatine, extract of beef, bark and wood extract and caustic soda; as well as slaughtering and rendering establishments, where it is used to concentrate tank water.

The use of fresh water for marine boilers has become a matter of necessity with the progress of engineering and the universal adoption of high pressure. On long voyages the carrying of a supply of fresh water to replenish waste is, of course, not to be thought of. The attention of engineers has, therefore, been urgently directed to processes of distillation of sea water. Nothing that has been found can compare with the Yaryan apparatus for this purpose. Its high evaporative power, its small size and weight, the fact that but a small amount of water is carried in the machine at any one time, its freedom from scaling, its automatic and continuous action, and the ease with which all its parts can be reached for examination and repair, recommend it above all other machines.

For distilled water for domestic purposes, nothing has hitherto been devised which offered a satisfactory solution to the crying need in many of our cities for pure water for drinking purposes. Germs of typhoid and other insidious diseases held in the water, the native element and best of all breeding places for bacteria, cause hundreds upon hundreds of deaths each month. Freezing does not affect them except to make them torpid, so that ice formed on ponds holding the germs of typhoid or typhus may become a deadly poison. For this reason artificial ice made from distilled water is rapidly growing in favor and displacing —even at an increased cost—natural ice, which may bring disease or death into the household.

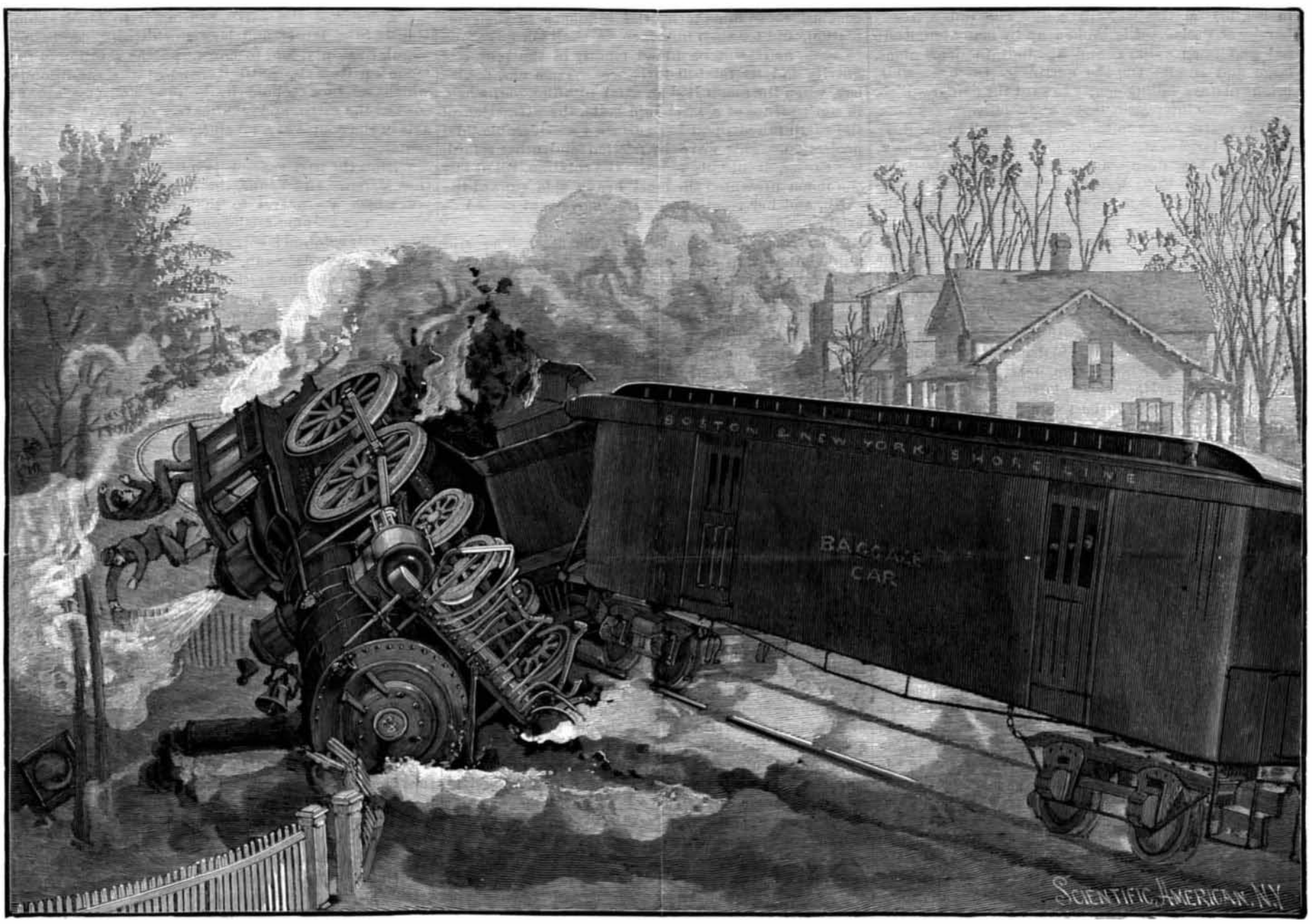
To the manufacturer of artificial ice the Yaryan evaporator, which enables him to obtain distilled water at four times the economy of the old process of distillation, is a *sine qua non*.

In several cities the distribution of distilled water by pipes is seriously contemplated, using the Yaryan process of distillation. At present a large business is done by several companies who furnish distilled water, either in bulk or in bottles, at a cost of from 10 cents a gallon upward. Already a plant for production of distilled water on a large scale is under construction, by means of which it is confidently claimed that absolutely pure water will be produced at a cost of less than fifty cents a thousand gallons.

It may well be considered whether the Yaryan system of evaporation does not offer the much needed solution of the problem of the disposition of the sewerage of cities. By means of this process, a fertilizer could be produced from sewage water which could be sold as a commercial fertilizer.

A REMARKABLE RAILROAD ACCIDENT.

A noteworthy instance of the very singular manner in which railway accidents sometimes take place, and where the escape from great loss of life seems little less than miraculous, was afforded by the wreck on the Shore Line Railroad, a little east of New Haven, on April 18, which forms the subject of the accompanying illustration.



A RAILWAY ACCIDENT—N. Y., N. H. & H. R.R.

The east bound Boston and New York Express left New Haven at 3:05 P. M. The train consisted of the locomotive, one baggage car, and four passenger cars. It had just passed over the long Quinnipiac River bridge, and was rounding a curve, when the flange of the left hand forward truck wheel of the locomotive broke, and a portion of the wheel nearly eighteen inches long flew off. The train had been going at the rate of only about twelve or fifteen miles an hour over the bridge, and the engineer had just opened the throttle for full speed when the accident happened. With the breaking of the flange, the wheel left the track on the curve, the other truck wheels and the driving wheels also being derailed and bumping along on the ties for some distance, as the locomotive was pushed ahead by the impetus of the train, the locomotive being finally turned completely around and thrown to one side of the track, landing in a partially crosswise position over a shallow ditch or gully. The engineer had been leaning from his cab window, and he was pitched forward into the ditch, the locomotive falling over him, but not upon him, so that he was enabled with a little assistance to crawl out, not having received any serious injuries. The fireman likewise went over in the cab and was thrown out into the mud and water of the ditch. The engineer saw the truck wheel strike the ties, and instantly put on the air brakes and blew the whistle.

Just beside the track, at the place where the accident happened, is a private residence, from which the manner of its occurrence was noted by eyewitnesses. It is said that the momentum of the train appeared to lift the rear end of the locomotive, so that the frame of the cow catcher caught in some heavy planking at the side of the track, when the locomotive was made to turn almost a complete somersault before it landed in the ditch. The tender, which had been drawn from the rails by the engine, was finally swung around and landed in the ditch to the rear of the locomotive, its forward end also pointing in a direction opposite to that in which it had been going. The connecting link between the tender and baggage car was broken, and the latter was pushed into an embankment on the opposite side of the track, when all further progress of the train was stopped, the first passenger coach, which had not left the track, being brought to a standstill immediately opposite the derailed and overturned locomotive, which but a moment before was pulling the train.

The damage to the locomotive was by no means as great as might have been expected, although the cab was broken to pieces, the cow catcher broken and its rods twisted out of shape, and the iron sheathing punctured and ripped in many places. The locomotive was built in 1873, and was to have been taken to the repair shops the next week. The engineer testifies to having tried the wheel with a hammer before the train left New Haven, but a few minutes previous to the accident, and that he found it good and sound. It would have been a little remarkable for the truck wheel to have left the track in such a manner had it not been that the engine was on a curve, and the comparatively slow rate at which the train was moving tended to minimize the danger. As it was, there were not a few of the passengers who felt profoundly thankful that the accident had not happened some four hundred feet further back, when the entire train might have been precipitated from the high bridge into the Quinnipiac River.

To get a good polish on mahogany easily: Mix one part of boiled linseed oil with two parts of alcoholic shellac varnish. Shake well before using. Apply in small quantities, with a cloth, and rub the work vigorously until the desired polish is secured.